NOISE REDUCTION SCHEME FOR A COMPUTER SYSTEM

Technical Field of the Invention

The present invention relates generally to noise reduction schemes and in particular to a noise reduction scheme implemented within a computer system.

Background of the Invention

Mobile computer systems, such as laptop or notebook computers, usually include a CD- ROM drive which can be used for music enjoyment. Typically, a user listens to an audio CD through a standard set of headphones while typing or using the computer. Further, audio may be enjoyed by the user from other sources, such as DVD drives and other storage devices, and network connections as well as part of games and other applications which provide an audio component.

Since a notebook computer is mobile, the user is able to operate the computer in a variety of locations while still listening to audio via the headphones. However, many of these locations present a noisy environment to the user. The quality of the audio heard by the user is reduced when mixed with background noise from the local environment. For instance, when a user listens to music while operating the notebook computer on an airplane flight, engine noise is mixed in with the audio provided from the CD, even when using headphones. Office locations also present noisy environments to the user.

Consumer electronic manufacturers have introduced standalone headphones that have a noise reduction system incorporated directly into the headphone. Since a standard headphone set does not contain any processing capability, manufacturers of the noise reduction headphones add a microcontroller or digital signal processor (DSP) to provide a noise canceling signal. Noise reduction systems detect ambient sound surrounding the user and generate a sound wave which is opposite the sensed

ambient sound. The opposite sound wave is combined with the ambient sound, resulting in cancellation of the ambient sound.

Because these standalone headphones have noise cancellation capability, they are more costly than a standard headphone set. The addition of a microcontroller or a DSP, and a built-in microphone to collect the ambient noise contribute directly to the increased cost, which in general may be as much as five times more than the standard headphone set.

Therefore, what is needed is a cost effective way to reduce or cancel environmental background noise normally heard by a user through a standard set of headphones while listening to audio while using a mobile computer system. For the reasons stated above, and for other reasons stated below which will become apparent to those skilled in the art upon reading and understanding the present specification, there is a need in the art to provide a noise reduction scheme for a mobile computer system without incorporating additional circuitry directly into a standard headphone set.

Summary of the Invention

A noise reduction scheme is incorporated into a mobile computer system for reducing environmental background noise when a user is listening to audio output of a mobile computer. A noise cancellation algorithm is executed by the computer's microprocessor for generating a noise cancellation signal in response to environmental background noise detected by a microphone built into the mobile computer system. A digital signal processor within the mobile computer system mixes the noise cancellation signal with audio provided by the mobile computer for providing an enhanced audio signal to a user listening to the audio output through a standard set of headphones.

In one embodiment, a noise reduction scheme implemented within a computer system having an optical disc drive is presented. A built-in microphone

detects ambient noise. A noise cancellation algorithm executed by a microprocessor generates a noise cancellation signal responsive to the detected ambient noise. A digital signal processor mixes the noise cancellation signal with an audio signal provided from a compact disc playing in the optical disc drive, wherein the mixed signal is applied to a headphone output connection. In further embodiments, the source of the sound is from the group consisting of DVD, network connection, hard disk drive and various application programs which utilize sound.

In another embodiment, a method of reducing ambient noise normally heard by a user through headphones when listening to audio from a mobile computer system is provided. The method comprises the steps of detecting the ambient noise, executing a noise cancellation algorithm wherein a noise cancellation signal is generated in response to the detected ambient noise, and mixing the noise cancellation signal with the audio from the compact disc wherein the mixed signal is applied to the headphones.

An advantage of implementing a noise cancellation scheme within a mobile computer system is that environmental background noise is reduced when a user listens to audio via a standard set of headphones. This is particularly beneficial to a user operating the computer in a noisy environment, such as on an airplane or in a crowded office. Because the noise cancellation scheme is implemented within the mobile computer system, a standard set of headphones are used for listening to audio directed to the headphone audio connection.

Therefore, a noise reduction scheme implemented within a mobile computer system allows components normally inherent with the computer system to support a noise cancellation algorithm. In different embodiments of the invention alternative methods of executing the noise cancellation algorithm of varying scope are described. For instance, the noise cancellation algorithm is automatically executed by the computer's microprocessor when the optical disc drive is active or the algorithm is manually executed that a software interface. Still other and further

embodiments, aspects and advantages of the invention will become apparent by reference to the drawings and by reading the following detailed description.

Brief Description of the Drawings

Figure 1 illustrates a computer serving as an environment for the present invention.

Figure 2 is a block diagram of an embodiment of a noise reduction scheme implemented within a computer according to the teachings of the present invention.

Figure 3 is a flow chart showing one embodiment of the steps necessary for providing a noise reduction scheme for a computer.

Detailed Description of the Embodiments

In the following detailed description of the embodiments, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration specific embodiments in which the inventions may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that logical, mechanical and electrical changes may be made without departing from the scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present inventions are defined only by the appended claims.

The present invention is a noise reduction scheme implemented within a mobile computer system for reducing environmental background noise heard by a user while listening to audio through a standard set of headphones. A noise cancellation signal is generated by the computer's main processor in response to environmental background noise detected by a built-in microphone. The noise cancellation signal is then mixed with audio output provided by an application program or device such as a CD drive, DVD drive, network connection or other

device for canceling or reducing environmental background noise heard by the user while listening to such audio output through the headphones. A mobile computer system serving as an environment for the present invention is first described followed by a block diagram of an embodiment of a noise reduction scheme implemented within such a computer system. A flow chart describing the processing steps for a noise reduction scheme is also presented.

Figure 1 illustrates a computer 10 serving as an environment for the present invention. Computer 10 is a mobile computer such as a laptop or notebook computer, and may be of any type, including a Gateway Solo series computer system. The notebook computer 10 includes an integrated monitor 12, a pointing device 14, a keyboard 16, and a compact disc-read only memory (CD-ROM) optical disc drive 18 for receiving and playing a CD. Reference number 18 is also representative of any other device which provides audio, such as a network connection, a DVD drive, or other similar device, including applications such as games running on computer 10. An integrated source of power is also provided in computer 10. Audio output from the computer 10 is directed to an audio output connection such as built-in speakers 20 or a headphone output connection 22. As illustrated in Figure 1, a standard set of headphones 24 are connected to the headphone output connection 22 for bypassing the speakers 20 and for allowing a user to listen to audio via the headphones 24. A built-in microphone 30 is also integrated into the notebook computer 10.

The notebook computer 10 further includes a microprocessor, random access memory (RAM), read only memory (ROM), and one or more storage devices, such as a hard disk drive, and a floppy disk drive (into which a floppy disk can be inserted). The construction and operation of such notebook computers are well known in the art. The presented invention is not limited to notebook computers, and is applicable to other computing systems that can provide audio output, such as

desktop computer systems, set top boxes, and combined television and computer or set top box devices.

The monitor 12 permits the display of information for viewing by a user of the notebook computer 10. The monitor 12 is a flat panel display, such as a liquid crystal display (LCD). Other types of displays are acceptable, such as CRTs, plasma and projection to name a few. The pointing device 14 permits the control of the screen pointer provided by the graphical user interface of operating systems such as versions of Microsoft Windows. The notebook computer 10 is not limited to any particular pointing device 14. Such pointing devices include a mouse, a touch pad, a trackball and a pointing stick.

Figure 2 is a block diagram of an embodiment of a noise reduction scheme implemented within a notebook computer 10 according to the teachings of the present invention. Environmental background noise is detected by the built-in microphone 30. The placement and the number of microphones utilized for detecting ambient background noise is not limited by the present invention. In one embodiment, a single microphone 30 is placed near the upper portion of the monitor 12, as illustrated in Figure 1. In another embodiment, multiple microphones (not shown) are placed on the backside of the computer 10. A microphone may be remote or wired and moved as desired by a user to provide optimal cancellation.

The microphone(s) 30 should not be placed directly adjacent to the keys on the keyboard 16 in order to properly cancel noise generated by a user typing. If the microphone 30 detects a higher level of noise because of its proximity to the keyboard 16, then the noise cancellation signal generated includes over-correction for a noise not heard at the same level by the user. In another alternative embodiment of the noise cancellation scheme, a profile for key clicks is included as part of the noise reduction scheme so that a noise cancellation signal is generated without over compensating for key click noise when a user is typing on the keys. Therefore, an

imbalance in the keyboard noise level detected by the microphone 30 and the noise level as heard by the user is minimized.

Analog noise detected by the microphone 30 passes through an analog to digital convertor (not shown) for conversion into a digital signal. The digitized noise signal is applied to the microprocessor 32 of the computer 10. The microprocessor 32 executes a noise cancellation module implementing well known algorithms to generate a reverse or negative noise signal in response to the received digitized noise signal. The present invention is not limited to any particular noise cancellation algorithm, which varies in complexity and processing requirements. However, noise cancellation algorithms are well known to those skilled in the art.

Execution of the noise cancellation algorithm by the microprocessor 32 is activated by a user through a software interface. In an alternative embodiment, the noise cancellation algorithm is activated automatically when the CD-ROM drive 18 or other such source of audio output is activated, which may be detected in one of several well known ways, including receiving the signals causing activation of such sources.

The noise cancellation signal generated by the microprocessor 32 is received by a digital signal processor (DSP) 34. A sound board contained within the computer 10 typically contains one or more DSPs 34, one of which is utilized for mixing the noise cancellation signal with the audio output of the computer 10 using known mixer functionality. The resultant or multiplexed signal is converted back to an analog signal and applied to an audio output port 36.

The audio output port 36 is coupled to one or more speakers 20 and to a headphone output connector 22. The headphone output connector 22 is adapted to receive a standard set of headphones 24. When a user is listening to CD or other audio via the headphones 24, the audio quality heard by the user is enhanced because the environment or ambient background noise has been reduced.

Although not as practical, audio quality heard using the speaker(s) 20 would also be enhanced by operation of the noise reduction scheme. However, a more sophisticated noise cancellation algorithm would be required, which would demand greater processing requirements from the microprocessor 32.

By utilizing built-in components of the mobile notebook computer 10, a user is able to enjoy enhanced sound quality when listening to audio from a CD or other source using a standard set of headphones 24. Built-in components include the microphone 30, the CD-ROM 18 drive or other source, the headphone output connection 22, the microprocessor 32, and the DSP 34. All of these components are typically inherent with the mobile notebook computer 10. However, if the computer 10 is missing any of the required components, they can be added as necessary.

Figure 3 is a flow chart showing one embodiment of the steps necessary for providing a noise reduction scheme within a notebook computer 10. The flow chart may be representative of a computer program written in any of several languages, such as C++, which is an object oriented language, or in procedural code. The number of objects or modules of code may or may not correspond one to one with the steps represented in the flow chart. Further, the code may be run from main memory, and loaded from secondary storage such as cd rom, disk drive, network connection, floppy or any type of machine or computer readable medium. Further, the flow chart may also be implemented in software, hardware, firmware or any combination thereof.

Referring to step 40, the CD-ROM drive 18 is activated. Activation means that a CD has been inserted into the CD-ROM drive 18 and audio encoded within the CD is directed to an audio output port 36.

In step 42, the noise cancellation algorithm residing within the microprocessor 32 is activated. In one embodiment, the noise cancellation algorithm is automatically activated in response to an active CD-ROM drive 18. In another embodiment, the user activates the noise cancellation algorithm through a software

interface such as a common graphical user interface, drop down menu selection, command line or other type of interface. Implementation of either one of these steps are well known to those skilled in the art.

In step 44, a built-in microphone 30 samples environmental or ambient background noise. This is followed by step 46, wherein a negative or reciprocal audio signal is generated in response to the noise detected in step 44. After the reciprocal noise signal has been generated, it is combined with the audio signal provided by the CD-ROM drive 18 (step 48). The combined signal is applied at either a speaker(s) 20 or to a headphone output connection 22 wherein a user listens to the audio through a standard set of headphones 24.

A noise reduction scheme has been described for a mobile computer 10 for enhancing sound quality heard by a user listening to audio from a CD using a standard set of headphones 24. A built-in microphone 30 detects environmental background noise, wherein a noise cancellation algorithm residing in the microprocessor 32 of the computer 10 is activated to generate a negative or reciprocal signal in response to the detected noise. This negative or reciprocal noise signal is mixed in a DSP with audio from the CD playing in a CD-ROM drive 18. The resultant audio signal reduces the environmental background noise normally heard by a user when listening to audio from the CD through a standard set of headphones 24.

Although specific embodiments have been illustrated and described herein, those of ordinary skill in the art will appreciate that any elements or arrangements of elements capable of achieving the same purpose may be substituted for the specific forms shown. In particular, while a CD-ROM drive 18 has been described with respect to the flowchart of Figure 3, other devices, such as DVD drives, network connections over which sound files are obtained and application programs such as games can also cause activation of the noise cancellation algorithm which activated.

This patent is intended to cover all adaptations or variations of the invention, limited only by the following claims and equivalents thereof.